Relationship between the Investments in IT with Firm Financial Performance: Evidence from Tehran Stock Exchange

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ABSTRACT

In present study, we examine the relationships between investment in information technology (IIT) and firm financial performance (FFP) of the listed companies on the Tehran Stock Exchange (TSE). Data were gathered from the audited financial statements of the firms provided by TSE's website from 2010 to 2015. The results of multiple linear regression analysis show that investments in information technology have significant effects on Return on Investment. Investment in information technology isn't significantly related to return on equity. Investments in information technology were significantly related to return on sales and sales growth. There is a no significant relationship between earnings per share and investment in information technology. Also, there is a no significant relationship between dividend per share and investment in information technology. However, the results of fuzzy regression analysis indicate significant relationships between the independent variable except financial performance (FFP).

INTRODUCTION

Today, IT is playing an ever larger role in all aspects of production, marketing, distribution and sales. Information technology in recent years has been the driving factor productivity lots of achievements. Huang et al (2006) investigated the association between IT investment and firm performance. Their Results indicated that firms with high levels of IT infrastructure and human-IT resources have a strong positive relationship with IT-enabled intangibles, but not with firm performance. In addition, IT-enabled intangibles are strongly positively correlated with firm performance. Floyd and Wooldridge (1990) evaluated the impact of competitive strategy on information technology (it) and of it on organizational performance. The results lend statistical support to the strategy–it

relationship described in case studies, and in addition, provided an explanation for inconsistent findings in previous it performance research. Lee and Kim (2006) discussed the positive effects of IT investment on firm financial performance when a distinct range of characteristics is examined. The relationship between IT investment and firm performance considering the information intensity of the industry is explored using a distributed lag model. Findings indicate both a positive effect and a positive lag effect of IT investment. The effects of IT investment in the high information-intensive industry are significantly larger than in the low information-intensive industry. In this study, we examine the relationship between investment in information technology and firm financial performance. Our paper delivers new evidence on the link between (IIT) and (FFP). Section 2 motivates the study and lists the hypotheses to be tested. Section 3 describes our research design, including measurement of primary variables and empirical specification. Section 4 describes sample selection and descriptive statistics, the results from our regression analyses. And Section 5 concludes.

1.1 Literature Review and Hypotheses

Chae et al (2014) reexamined the link between IT capability and firm performance. The results of their current analysis showed no significant link between IT capability and firm performance. They discussed several possible causes for the change in findings and present an in-depth comparison in business performance between the two groups--IT leader and control--over a period extending from 1991 to 2007.

Dewan and Shi (2007) developed empirical proxy measures of information technology (IT) risk and incorporates them into the usual empirical models for analyzing IT returns: production function and market value specifications. Their results showed that IT capital investments make a substantially larger contribution to overall firm risk than non-IT capital investments. Firms with higher IT risk have a higher marginal product of IT relative to firms with low IT risk. They estimated that about 30% of the gross return on IT investment corresponds to the risk premium associated with IT risk. Their findings indicated that IT risk provides part of the explanation for the unusually high valuations of IT capital investment in recent research.

Jae Hae et al (2011) used meta-analysis techniques to investigate research choices that affect findings with respect to the return on IT investment. They found, that the relationship between IT investment and performance varies, depending on how both financial performance and IT investment are measured. Despite criticism of accounting measures as indicators of IT payoff, they found that the relationship is often stronger in studies that employ accounting measures rather than market measures of firm performance. They discussed the practical implications of the results of our meta-analysis and suggest new directions for future theory development and research.

Adi Masli (2011) investigated the impact of superior IT capabilities on firm performance over the 1988–2007 periods, which allowed them to consider the structural shifts in the return of IT capability over time. Their results suggested that firms with superior IT capabilities were able to attain higher firm performance levels until 1999. They also found that a subset of firms that sustain high levels of IT capabilities during the period 1988 to 2007 continue to perform better than their peers.

Farhanghi et al (2013) investigated the effect of information technology (IT) on organizational structure (OS) and firm performance (FP). Their results showed that IT has a direct and indirect impact on FP. OS is found to have a direct effect on FP. Finally IT has a direct effect on OS. Hung et al (2012) examined the impacts of ATMs, one of the most widely accepted SSTs, on bank financial performance. Their results showed ATMs have a positive relationship with profitability. They found no association between ATMs and growth performance.

Adi Masli(2011) investigated the link between information technology investment and business value. They examined financial and non-financial measures to represent different elements of business value and they survey IT investment measures and links with firm performance and they examined IT and business complementarities that affect firm performance. They showed the impact of business context and IT alignment with business strategy on resulting performance.

Kalkan et al (2011) investigated the impact of firm size, information system and the technological architecture associated with prospector strategy on performance of firms operating in Isparta, in Turkey. They focused on the interactions between firm size, prospector strategy, technological architecture and firm performance. They identified the relationships between firm size and the technological architecture on prospector strategy that support the firm performance best. Technological architecture was identified. The firm size has been measured in terms of employment. Environmental conditions offered many opportunities to firms. The strategic activity has been taken as prospector. The firm performance is based on the sales growth and profitability.

Lio et al (2013) found that the core information technology (IT) employees with firm specific skills are value-adding resources that aid the firm's performance whereas peripheral employees with less firm specific skills provide no value to the firm performance. They found that the economic impact of the presence of core IT employees is moderated by the organization's non-IT investment intensity. Their findings of the research provided insights that help to expand the understanding of resource complements and the role of strategic human resources in a firm.

Rong et al (2006) investigated the association among strategy, the extent of IT applications to 12 planning and control functions, and firm performance. Special attention was paid to the moderating effect on these relationships of 15 technical, human, and organizational impediments to IT implementation. They analyzed survey data obtained from 296 Taiwanese companies, supplemented by financial data from publicly disclosed financial reports. Their results indicated that strategy significantly influenced the extent of IT applications for planning and control. In turn, the extent of IT applications had a significant direct effect on firm performance, while the direct effect of strategy was insignificant. The relationship between strategy and the extent of IT applications, and between the latter and firm performance were both stronger when the level of impediments to IT implementation was low.

Broadbent and Weill (1997) explained how successful firms create business-driven IT infrastructures. Some firms did not invest in a firm wide infrastructure, while others invest up to 10 percent of their revenues in an IT infrastructure, such as communication networks, databases, and expertise that is shared across multiple business units. Both approaches may be correct, provided they match the firm's specific needs.

Kyeong et al (2009) investigated the effects of IT investment on firm financial performance in the electronics industry of China, still classified as a developing country, and compare it with the United States. They found that IT investment has a positive impact on firm performance in China. Moreover, the impact in China was not different from what occurred in the United States in terms of direction and the size against the assertion of previous studies and expectations.

We extend this work by investigating the following question: What is the relationship between investment in information technology and firm financial performance? This question leads to the sixth following hypotheses in this paper:

- **H₁:** There is a significant relationship between investment in information technology (IIT) and Return on Investment (ROI).
- **H₂:** There is a significant relationship between (IIT) and Return on equity (ROE).
- **H₃:** There is a significant relationship between (IIT) and Return on sales (ROS).
- **H₄:** There is a significant relationship between (IIT) and Sales growth (SG).
- **H₅:** There is a significant relationship between (IIT) and Earnings per share (EPS).
- **H₆:** There is a significant relationship between (IIT) and Dividend per share (DPS).

## 1.2 Data, Variables and Model
1.2.1 Data

The data is collected from 94 samples firms listed in Tehran Stock Exchange for the period from 2010 to 2015. Table 1 provides mean, median, standard deviation, maximum, and minimum values for the research variables. The sample comprises firms that meet the following conditions:

1. Firms that have been listed in the stock exchange before 2015;
2. Firms whose financial year ends at the end of the Iranian calendar;
3. Firms that have no financial year changes;
4. Firms that have been operating in TSE during the period of interest;
5. Firms that have data available for the period of interest;
6. Investment companies are excluded. Given these conditions, 94 firms were selected as sample.

1.2.2 Research Analytical Model

The present research uses the model proposed by (Lee et al, 2006). In this model is expected to invest in information technology to increase the firm financial performance.
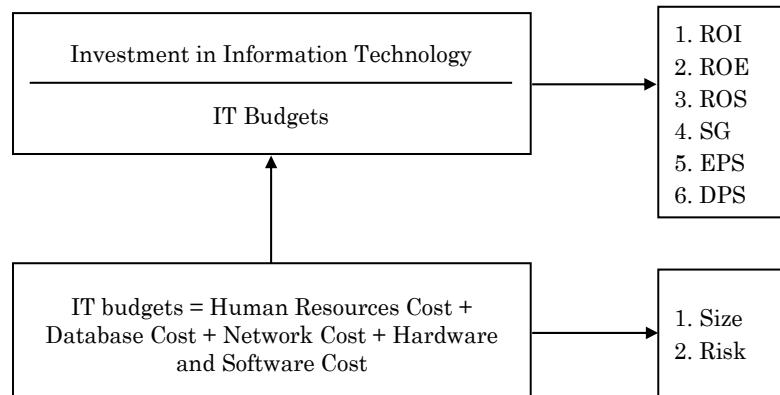
1.2.3 Research Model

The present research uses the model proposed by (Lee et al, 2006). The present research uses the model proposed for the hypotheses:

$$FFP = \beta_0 + \beta_1 IIT_{t-1} + \beta_2 LNSIZE_t + \beta_3 RISK_t + \varepsilon_t$$

1) $ROI_t = \beta_0 + \beta_1 IIT_{t-1} + \beta_2 LNSIZE_t + \beta_3 RISK_t + \varepsilon_t$

2) $ROE_t = \beta_0 + \beta_1 IIT_{t-1} + \beta_2 LNSIZE_t + \beta_3 RISK_t + \varepsilon_t$

3) $ROS_t = \beta_0 + \beta_1 IIT_{t-1} + \beta_2 LNSIZE_t + \beta_3 RISK_t + \varepsilon_t$

4) $SG_t = \beta_0 + \beta_1 IIT_{t-1} + \beta_2 LNSIZE_t + \beta_3 RISK_t + \varepsilon_t$

5) $EPS_{i,t} = \beta_0 + \beta_1 IIT_{t-1} + \beta_2 LNSIZE_t + \beta_3 RISK_t + \varepsilon_t$

6) $DPS_t = \beta_0 + \beta_1 IIT_{t-1} + \beta_2 LNSIZE_t + \beta_3 RISK_t + \varepsilon_t$

1.2.4 Research Variable

(i) Dependent Variable: In this study, the dependent variable is firm financial performance (ROI, ROE, ROS, SG, EPS, and DPS).

$$ROI = \frac{NET\ INCOME}{TOTAL\ INVESTMENT}$$

$$ROE = \frac{ROI}{1 - DEBT\ RATIO}$$

$$ROS = \frac{NET\ INCOME}{NET\ SALES}$$

$$SG = \frac{NET\ SALES_T - NET\ SALES_{T-1}}{NET\ SALES_{T-1}} * 100$$

$$EPS = \frac{NET\ INCOME}{N}$$

$$DPS = \frac{NET\ INCOME - Retained\ earnings - Accumulated\ capital}{N}$$

(ii) Independent Variable: In this study, the independent variable is investment in information technology. The present research uses the model proposed by:

IT Budgeiardware + Software + Database + Network + Human - IT resources.

(iii) Control Variable: In this study, the control variables are firm size, risk.

$$RISK = \frac{\sqrt{VARIANCE_{(NET\ INCOME)}}}{\sqrt{\sqrt{MEAN_{(NET\ INCOME)}}}}$$

SIZE: It is the natural logarithm of total sales for firm.

1.3 Sample Selection and Descriptive Statistics

Multivariate regression analysis was applied at the 5% significance level for testing the hypotheses. Descriptive and inferential (multivariate regression analyses) analyses are used for testing the hypotheses of the research.

1.3.1 Descriptive Analysis

Table – 1: *Descriptive Statistics*

	N	Mean	Minimum	Maximum	Std. Deviation
IIT	470	3.25	2.02	6.03	1.02
ROI	470	17.25	4.21	52.1	10.82

ROE	470	60.23	13.70	172.08	32.47
ROS	470	22.12	5.32	88.39	15.45
SG	470	39.25	19.32	328.32	38.20
EPS	470	20.33	6.23	14.25	25.32
DPS	470	31.20	7.71	132.01	34.28
SIZE	470	12.80	11.27	40.80	0.98
RISK	470	45.23	9.08	150.23	26.30

In the regression model, the effect of the independent variable (IIT) on the FFP (ROI, ROE, ROS, SG, EPS, and DPS) of the sample firms is examined. A multivariate linear regression model is used at the 5% significance level for testing the hypotheses. If there is no relationship between the independent variable and the dependent variable, all the coefficients in the regression model must be equal to zero. Thus, we can test the significance of the regression model, which is often done using F test. If the obtained F-statistic is less than the Table value of F at the 95% confidence level, the regression model will be significant.

1.3.2 Regression Analysis

Table – 2: *The Results of Estimating the Regression Model (1)*

	B	**t-statistic**	**sig**
CONSTANT	-14.302	-0.635	0.612
IIT	4.204	3.218	0.013
SIZE	1.952	0.956	0.41
RISK	0.016	0.329	0.741

Table – 3: *Model Summary*

Model	Adjusted R Square	F	Durbin-Watson	Sig
1	0.058	4.128	1.663	0.017

Hypothesis 1

According to the first hypothesis (IIT) is significantly associated with ROI. Based on the results of multivariate regression model (Table 2), IIT has a beta coefficient of 4.204 and p-value of 0.013 therefore; there is a significant relationship between IIT and ROI at 5% significance level.

Table – 4: *The Results of Estimating the Regression Model (2)*

	B	**t-statistic**	**sig**
CONSTANT	-1.8.987	-2.324	0.210
IIT	6.985	2.689	0. 181
SIZE	14.652	2.012	0.062
RISK	-0.198	-0.458	0.750

Table – 5: *Model Summary*

Model	Adjusted R Square	F	Durbin-Watson	Sig
2	0.042	1.888	1.599	0.0149

Hypothesis 2

According to the second hypothesis (IIT) is significantly associated with ROE. Based on the results of multivariate regression model (Table 4), IIT has a beta coefficient of 6.985 and p-value of 0. 181 therefore; there is a no significant relationship between IIT and ROE at 5% significance level.

Table – 6: *The Results of Estimating the Regression Model (3)*

	B	t-statistic	sig
CONSTANT	26.325	1.009	0.420
IIT	6.198	4.542	0.000
SIZE	-2.326	-0.519	0.689
RISK	-0.715	-3.110	0.039

Table – 7: *Model Summary*

Model	Adjusted R Square	F	Durbin-Watson	Sig
3	0.289	9.687	1.741	0.000

Hypothesis 3

According to the third hypothesis (IIT) is significantly associated with ROS. Based on the results of multivariate regression model (Table 6), IIT has a beta coefficient of 6.198and p-value of 0.000 Therefore; there is a significant relationship between IIT and ROS at 5% significance level.

Table 8. *The Results of Estimating the Regression Model (4)*

	B	t-statistic	sig
CONSTANT	170.058	-3.874	0.044
IIT	9.258	2.587	0.045
SIZE	14.258	1.98	0.059
RISK	0.412	2.658	0.021

Table – 9: *Model Summary*

Model	Adjusted R Square	F	Durbin-Watson	Sig
4	0.214	5.985	2.198	0.001

Hypothesis 4

According to the third hypothesis (IIT) is significantly associated with SG. Based on the results of multivariate regression model (Table 8), IIT has a beta coefficient of 9.258 and

p-value of 0.045 therefore; there is a significant relationship between IIT and SG at 5% significance level.

Table – 10: *The Results of Estimating the Regression Model (5)*

		B	**t-statistic**	**sig**
	CONSTANT	12.358	2.658	0.059
	IIT	7.214	1.658	0.063
	SIZE	-4.325	-3.154	0.058
	RISK	-0.587	-2.981	0.181

Table – 11: *Model Summary*

Model	Adjusted R Square	F	Durbin-Watson	Sig
5	0.121	6.325	1.602	0.132

Hypothesis 5

According to the third hypothesis (IIT) is significantly associated with EPS. Based on the results of multivariate regression model (Table 10), IIT has a beta coefficient of 7.214and p-value of 0.063 Therefore; there is a no negative significant relationship between IIT and EPS at 5% significance level.

Table – 12: *The Results of Estimating the Regression Model (6)*

		B	**t-statistic**	**sig**
	CONSTANT	109.258	2.365	0.210
	IIT	9.874	2.148	0.320
	SIZE	-5.258	-3.021	0.059
	RISK	-0.987	-2.742	0.324

Table – 13: *Model Summary*

Model	Adjusted R Square	F	Durbin-Watson	Sig
6	0.235	6.258	1.589	0.048

Hypothesis 6

According to the third hypothesis (IIT) is significantly associated with DPS. Based on the results of multivariate regression model (Table 12), IIT has a beta coefficient of 9.874 and p-value of 0.320 therefore; there is a no significant relationship between IIT and DPS at 5% significance level.

Table – 14: *Results of Testing the Hypothesis with Multivariate Regression Analysis*

Hypothesis	**Sig**	**Result**
1	0.013	Accepted
2	0.181	Rejected

3	0.000	Accepted
4	0.045	Accepted
5	0.063	Rejected
6	0.320	Rejected

1.4 Fuzzy Regression

Simple Linear Regression defined based on probability distribution, is always confronted with some limitations due to the hypotheses inflexibility. Also, the statistical regression models are used only when the observations' distribution is done based on a statistical model. But, the fuzzy regression models, in addition to their flexibility in adaptation to natural conditions, are an efficient instrument for demonstrating the effects of those variables with the same features. Time fuzzy regression is used when the variables or the observations are imprecise and vague, and when the relationship between variables is imprecise, as well as when the hypotheses' accuracy is uncertain (in small samples).However, in many cases, one or more hypotheses may be rejected or due to the sample size the hypothesis cannot be supported. In such cases, the common models do not have the required reliability and performance. The next alternative method is fuzzy regression. This kind of regression can be used when the variables or the relevant observations are imprecise and vague; also when the relationship between the variables is imprecise; or when the hypotheses are not certainly true (particularly, when the sample is small). The current study employs the fuzzy regression with fuzzy coefficients to examine the model.

The regression model: $FFP = \alpha_0 + \alpha_1 IIT + \alpha_2 LNSIZE + \alpha_3 RISK + \theta_i$

Assuming that: $y = FFP, x_1 = IIT, x_2 = LNSIZE, \ x_3 = RISK,$ and $\alpha_1 = (a_i, s_i)$, i=0,1,2,3

The objective function is expressed as follows:

$$z = 2 * 80 s_0 + 2 s_1 \sum_{j=1}^{80} |x_{1j}| + 2 s_2 \sum_{j=1}^{80} |x_{2j}| + 2 s_3 \sum_{j=1}^{80} |x_{3j}|$$

Two constraints are defined for each observation with a total of 416 constraints. For instance, the first two constraints are as follows:

$$(1-h)s_0 + (1-h)s_1|0.3| + (1-h)s_2|89| + (1-h)s_3|88| - a_0 + a_1|0.3| + a_2|89| + a_3|88| \geq -0.09$$

Minimizing the objective function (z) with respect to the 416 constraints as well as $s_0 \geq 0$ for i= 0,1,2,3 and $a_i = 0,1,2,3$ is a problem in linear programming that is solved by Lingo software. Solving the problem for $h\epsilon(0,1)$ leads to the data provided in Table15.

Table – 15: *Estimating the Objective Function Based on Different Membership Degrees*

h	s_0	z
0.1	0.39	79
0.2	0.43	89
0.3	0.49	103
0.4	0.57	119
0.5	0.24	142
0.6	0.86	179

Considering the above Table, we will have the following calculations for all the h values: $s_0 = s_1 = s_2 = s_3 = 0$ & $a_0 = 0.17, a_1 = 0.21, a_2 = 0.008, a_3 = 0.11$

By replacing the coefficients obtained in the regression model, for certain values of independent variables the output is fuzzy and in the form of symmetric triangular fuzzy numbers. Therefore, we defuzzify the output using Center of Area (COA) in MATLAB. Finally, the MSE of the model can be obtained by comparing the estimated model with real values. In this case, the final regression model is the one with the lowest MSE. The output of MATLAB is provided in Table 16.

Table – 16: *Estimating the Objective Function Based on Real Value*

h	α_0	MSE
0.1	0.171	0.0320
0.2	0.182	0.0313
0.3	0.172	0.0318
0.4	0.173	0.0320
0.5	0.180	0.0318
0.6	0.172	0.0317

Considering the Table above, the lowest MSE occurs when h=0.09.

Therefore, the fuzzy regression model is: $\tilde{y} = 0.17 + 0.21x_1 + 0.008x_2 + 0.11x_3$

Defuzzification gives the following model $y = 0.008 + 0.21x_1 + 0.008x_2 + 0.11x_3$

CONCLUSION

The present research examined the relationship between six variables (ROI, ROE, ROS, SG, EPS, and DPS) and amount of investment in information technology (IIT) of the firms listed in Tehran Stock Exchange. The results of multivariate regression rejected three the hypotheses of the research. The results of multiple linear regression analysis show that:

1. There is a significant relationship between IIT with ROI.
2. There is a no significant relationship between IIT with ROE.
3. There is a significant relationship between IIT with ROS.
4. There is a significant relationship between IIT with SG.
5. There is a no significant relationship between IIT with EPS.
6. There is a no significant relationship between IIT with DPS.

Therefore, there is a significant relationship between investment in information technology and firm financial performance.

This finding isn't consistent with results (Lee et al, 2006).also; this finding is consistent with results (Shi-Ming Huang et al, 2006). The limitation is related to the lack of classified data in the database of TSE. Therefore, the researchers were forced to use the audited reports of the firms and data collection became a very time consuming process.

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